

# The Implications of Regional Variations in Medicare Spending. Part 2: Health Outcomes and Satisfaction with Care

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**Background:** The health implications of regional differences in Medicare spending are unknown.

**Objective:** To determine whether regions with higher Medicare spending achieve better survival, functional status, or satisfaction with care.

**Design:** Cohort study.

**Setting:** National study of Medicare beneficiaries.

**Patients:** Patients hospitalized between 1993 and 1995 for hip fracture ( $n = 614\ 503$ ), colorectal cancer ( $n = 195\ 429$ ), or acute myocardial infarction ( $n = 159\ 393$ ) and a representative sample ( $n = 18\ 190$ ) drawn from the Medicare Current Beneficiary Survey (MCBS) (1992–1995).

**Exposure Measurement:** End-of-life spending reflects the component of regional variation in Medicare spending that is unrelated to regional differences in illness. Each cohort member's exposure to different levels of spending was therefore defined by the level of end-of-life spending in his or her hospital referral region of residence ( $n = 306$ ).

**Outcome Measurements:** 5-year mortality rate (all four co-

horts), change in functional status (MCBS cohort), and satisfaction (MCBS cohort).

**Results:** Cohort members were similar in baseline health status, but those in regions with higher end-of-life spending received 60% more care. Each 10% increase in regional end-of-life spending was associated with the following relative risks for death: hip fracture cohort, 1.003 (95% CI, 0.999 to 1.006); colorectal cancer cohort, 1.012 (CI, 1.004 to 1.019); acute myocardial infarction cohort, 1.007 (CI, 1.001 to 1.014); and MCBS cohort, 1.01 (CI, 0.99 to 1.03). There were no differences in the rate of decline in functional status across spending levels and no consistent differences in satisfaction.

**Conclusions:** Medicare enrollees in higher-spending regions receive more care than those in lower-spending regions but do not have better health outcomes or satisfaction with care. Efforts to reduce spending should proceed with caution, but policies to better manage further spending growth are warranted.

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See related article on pp 273-287 and editorial comments on pp 347-348, 348-349, and 350-351.

The inexorable growth of health care spending in the United States is widely believed to be due to the greater use of advanced technology of clear-cut benefit (1). Policymakers argue (and the public assumes) that any constraints on growth are likely to be harmful (1, 2). Studies of regional variations in spending and medical practice, however, call these assumptions into question. Earlier research has indicated that the nearly twofold differences in Medicare spending observed across U.S. regions are not due to differences in the prices paid for medical services (3, 4) or to differences in health or socioeconomic status (3, 5, 6). Recent research, some of which is presented in Part 1 of our study, indicates that regional variations in average per capita Medicare spending are not due to more frequent performance of major surgery (7, 8) and that regions with higher per capita spending are no more likely to provide higher-quality care, whether defined in terms of specific evidence-based services or in terms of greater access to basic health care (7, 8). The additional utilization in high-spending regions is largely devoted to discretionary services that have previously been demonstrated to be associated with the local supply of physicians and hospital resources (5, 6). These include the frequency and type of evaluation and management services provided by physicians, the use of specialist consultations, the frequency of diagnostic tests and minor procedures, and the likelihood of treating pa-

tients with chronic disease in the inpatient or intensive care unit setting.

Whether the specialist-oriented, more inpatient-based practice observed in high-spending regions offers important health benefits, however, is unknown. Although recent studies have found no benefit in terms of mortality (5, 9, 10), they had limited ability to adjust for possible case-mix differences, inadequate individual-level clinical detail, and limited outcome measures. Our study was designed to address these concerns. In Part 1, we reported on the relationship between regional differences in spending and the content of care, quality of care, and access to care provided to four cohorts of Medicare beneficiaries. In this article, Part 2, we describe associations between increased spending and mortality, functional status, and satisfaction with care.

## METHODS

### Design Overview

As described in greater detail in Part 1, we carried out a cohort study in four parallel populations using a "natural randomization" approach (11). In this approach, one or more exposure variables allow assignment of patients into "treatment groups" (different levels of average spending), as would a randomized trial. Because some of the regional differences in Medicare spending are due to differences in illness levels (enrollees in Louisiana are sicker than those in

Colorado) and price (Medicare pays more for the same service in New York than in Iowa), we could not use Medicare spending itself as the exposure. We therefore assigned U.S. hospital referral regions (HRRs), and thus the cohort members residing within them, to different exposure levels using a measure that reflects the component of regional variation in Medicare spending due to physician practice rather than regional differences in illness or price—the End-of-Life Expenditure Index (EOL-EI). Because regional differences in end-of-life spending are unrelated to underlying illness levels, it is reasonable to consider residence in HRRs with differing levels of end-of-life spending as a random event. The index was calculated as spending on hospital and physician services provided to a reference cohort distinct from the study cohorts: Medicare enrollees in their last 6 months of life. In the current paper, we also present several analyses with an alternative exposure measure, the Acute Care Expenditure Index (AC-EI), to decrease concern about possible residual confounding.

We confirmed that the exposures used to assign the HRRs achieved the goals of “natural randomization”: 1) Study samples assigned to different levels of the exposure (the EOL-EI) were similar in baseline health status, and 2) the actual quantity of services delivered to the individuals within the study samples nevertheless differed substantially across exposure levels and was highly correlated with average per capita Medicare spending in the HRRs. We followed the cohorts for up to 5 years after their initial hospitalizations and compared the processes of care (Part 1) and health outcomes (Part 2) across HRRs assigned to different exposure levels.

### Study Cohorts

The four study cohorts are described in detail in Part 1. Briefly, we studied fee-for-service Medicare enrollees, ages 65 to 99 years, who were eligible for Medicare Parts A and B. The acute myocardial infarction (MI) cohort was drawn from patients included in the Cooperative Cardiovascular Project, who had index hospitalizations between February 1994 and November 1995. The hip fracture and colorectal cancer cohorts were identified based on an incident hospitalization between 1993 and 1995. The general population sample included participants in the Medicare Current Beneficiary Survey (MCBS) who had initial interviews between 1991 and 1996 (for the survival analysis) or between 1992 and 1995 (for the other analyses) (see Appendix, section C, available at [www.annals.org](http://www.annals.org)).

Each cohort member was placed in a spending group according to the EOL-EI (as defined in detail in Part 1) in their HRR of residence at the time of the index hospitalization (chronic disease cohorts), or initial interview (MCBS cohort). Characteristics of the study cohorts were ascertained from a variety of sources, as described in detail in Part 1, including Medicare administrative files and claims (all four cohorts), chart reviews (acute MI cohort), in-person interview (MCBS cohort), U.S. Census data (at-

### Context

Per capita Medicare spending varies considerably from region to region. The effect of greater Medicare spending on mortality, functional status, and satisfaction is not known.

### Contribution

Using end-of-life care spending as an indicator of Medicare spending, the researchers categorized geographic regions into five quintiles of spending and examined costs and outcomes of care for hip fracture, colorectal cancer, and acute myocardial infarction. Residents of high-spending regions received 60% more care but did not have lower mortality rates, better functional status, or higher satisfaction.

### Implications

Medicare beneficiaries who live in higher Medicare spending regions do not necessarily have better health outcomes or satisfaction with health care than those in lower-spending regions.

—The Editors

tributes of ZIP code of residence, such as income, for the three chronic disease cohorts), and American Hospital Association data (to characterize hospitals).

### Assignment to Exposure Levels

As we summarized here and described in detail in Part 1, we used two approaches to determine cohort members' exposure to different levels of Medicare spending in their HRR of residence. Previous research has shown that the dramatic differences in end-of-life treatment across U.S. regions are highly predictive of differences in total spending (8, 12) but are not due to differences in case mix or patient preferences (13). Our primary measure of exposure was the EOL-EI, which was calculated as age-sex-race-adjusted spending (measured with standardized national prices) on hospital and physician services provided to Medicare enrollees who were in their last 6 months of life in each of the 306 U.S. HRRs in mid-1994 to 1997, excluding any members of the study cohorts (Appendix, Section E, available at [www.annals.org](http://www.annals.org).) We also repeated the major analyses with an alternative exposure measure, the AC-EI, which was based on differences across HRRs in risk-adjusted spending during an acute illness episode (Appendix, Section F, available at [www.annals.org](http://www.annals.org)). Both measures were highly predictive of average age-sex-race-adjusted Medicare spending at the HRR level ( $r = 0.81$  for the EOL-EI and  $0.79$  for the AC-EI in the acute MI cohort) and, as was shown in Part 1, of the regional differences in utilization experienced by the study cohorts. For many analyses, we grouped HRRs into quintiles of increasing exposure to the expenditure indices.

### Statistical Analyses

To assess the aggregate impact of any differences in individual attributes on average baseline risk for death across regions of increasing EOL-EI, we used logistic regression to determine each individual's predicted 1-year risk for death as a function of his or her baseline characteristics. The models had modest to excellent predictive ability (*c*-statistics were 0.61 for the colorectal cancer cohort, 0.68 for the hip fracture cohort, 0.77 for the acute MI cohort, and 0.82 for the MCBS cohort). We used these models to determine the average predicted risk for death across quintiles of Medicare expenditure indices.

### Mortality Analyses

The association between the HRR-level expenditure index and survival was assessed by using Cox proportional hazards regression models (14), with the expenditure index measured both as a categorical variable (in which each HRR was assigned to a quintile of Medicare spending based on the EOL-EI) and a continuous variable (using the value of the EOL-EI in the HRR of residence as the exposure). The survival models included independent variables to adjust for patient characteristics, hospital characteristics, and attributes of the HRR. Model fit was assessed by using methods for Cox model residuals to examine overall model fit, to test proportional hazards assumptions, and to identify influential observations. The main survival models underpredicted mortality in the first 6 months, possibly because of short-term complications that could not be adequately predicted with the available data; however, the models provided excellent prediction of 1-year mortality rates for each cohort.

The models are presented in **Appendix Tables 6 through 9** (available at [www.annals.org](http://www.annals.org)). To test whether the overall findings were consistent across subgroups of each cohort, we ran survival models stratified on all major variables. To test whether the findings were sensitive to our choice of the EOL-EI as our primary exposure, we repeated the analyses using the AC-EI. These sensitivity analyses are described in detail in the Appendix, Section F (available at [www.annals.org](http://www.annals.org)).

Patients in the same hospital are likely to be treated similarly, so their outcomes may not be statistically independent. We adjusted for within-hospital clustering by using overdispersed survival models, clustering by hospital (14). Model fit was assessed by carefully examining the data to identify HRRs that influenced estimates, predicted values, and likelihood ratio tests. Two moderately influential HRRs, Manhattan, New York, and Miami, Florida, were identified, both of which had relatively lower mortality rates and higher spending than predicted. Excluding these regions would have resulted in hazard ratios greater than those we report for quintile 5 (in the categorical model) and overall (in the continuous models). Analyses, however, are presented with these two HRRs included. We

used the STCOX routine of Stata 6.0 (Stata Corp., College Station, Texas) to perform survival analyses in the three chronic disease cohorts. For the analyses of the MCBS cohort, we used SUDAAN (Research Triangle Institute, Research Triangle Park, North Carolina) to account for sampling weights and the two-stage design (15).

### Change in Functional Status

We used the Health Activities and Limitations Index (HALex) as the primary dependent variable in our longitudinal analyses of changes in functional status (16, 17). The HALex was developed by the National Center for Health Statistics as a composite health status measure that can be calculated by using the responses to the National Health Interview Survey. For our longitudinal analyses, we assigned a HALex score of 0 to respondents who died. Loss to follow-up in these analyses occurred when patients failed to answer enough questions to allow a calculation of the score, did not participate in the survey, or entered a nursing home. Loss to follow-up was as follows: quintile 1, 7.8%; quintile 2, 8.9%; quintile 3, 8.4%; quintile 4, 9.6%; and quintile 5, 13.4%.

The effect of HRR spending on HALex score was modeled by using generalized estimating equation methods for the analysis of continuous longitudinal data (18). The dependent variable was the respondent's annual HALex score for up to 3 years. Each model controlled for individual attributes (**Appendix Table 10**, available at [www.annals.org](http://www.annals.org)) and included a variable for the time since the initial survey (0, 1, 2, or 3 years). Two sets of models were run, one including indicator variables for quintile of spending, the other including spending as a continuous variable. The principal hypothesis, that increased spending in the HRR of residence would be associated with a slower decline in health status, was tested through the interaction between the EOL-EI of the HRR and the length of time since the initial survey. Different model specifications were tested, both including and excluding interaction terms between time and the other control variables. All analyses yielded similar results for the tests of the principal hypothesis. The models are presented in **Appendix Table 10**, available at [www.annals.org](http://www.annals.org). We used the longitudinal sampling weight from the final interview for each respondent and then normalized across all cohort members so that the sum of the weights was equal to the total number in the cohort. The numbers of study participants reported incorporate these weights and are rounded to the nearest integer.

### Satisfaction with Care

This analysis was restricted to respondents with at least one physician visit in the previous year. The MCBS interview includes 20 questions on satisfaction with care. Eight items rate the general satisfaction with care received from physicians or hospitals within the past year, while 12 questions are asked only of respondents with a usual physician

**Table 1. Crude and Predicted Mortality Rates in Study Cohorts according to Level of Medicare Spending in Hospital Referral Region of Residence\***

Variable	Quintile of EOL-EI					Test for Trend†
	1 (Lowest)	2	3	4	5 (Highest)	
	←—————%—————→					
Hip fracture cohort						
Observed 30-day mortality rate	7.8	7.2	6.9	6.9	6.6	↓
Observed 1-year mortality rate	24.4	23.9	23.9	24.3	24.2	>0.05
Predicted 1-year mortality rate	24.5	24.1	24.1	24.1	23.9	↓
Colorectal cancer cohort						
Observed 30-day mortality rate	4.5	4.6	4.8	4.8	4.4	>0.05
Observed 1-year mortality rate	20.6	20.7	21.7	21.1	20.9	>0.05
Predicted 1-year mortality rate	21.1	20.8	21.2	20.8	20.9	>0.05
Acute MI cohort						
Observed 30-day mortality rate	18.5	18.4	19.2	18.2	18.5	>0.05
Observed 1-year mortality rate	30.7	31.3	32.6	31.6	33.3	↑
Predicted 1-year mortality rate	31.2	31.5	31.8	32.0	33.2	↑
MCBS cohort						
Observed 30-day mortality rate	0.2	0.4	0.4	0.3	0.2	>0.05
Observed 1-year mortality rate	4.6	4.8	5.0	5.1	5.3	>0.05
Predicted 1-year mortality rate	4.9	5.1	5.3	5.0	5.1	>0.05

\* Crude mortality rates were based on 30-day and 1-year follow-up for all cohort members with no censoring (follow-up for mortality was complete at 1 year for all). Predicted mortality rates were based on logistic regression equations that included individual- and ZIP code-level variables only. EOL-EI = End-of-Life Expenditure Index; MCBS = Medicare Current Beneficiary Survey; MI = myocardial infarction.

† Arrows show the direction of any statistically significant association ( $P \leq 0.05$ ) between the mortality rate and regional EOL-EI differences. An arrow pointing upward indicates that as spending increases across regions, the mortality rate increases. A  $P$  value greater than 0.05 was considered not significant.

(93% of the study sample) and focus on that physician's quality. Following the approach of others (19), we created two summary scores of general satisfaction with care (global quality and accessibility) and three summary scores focused on satisfaction with a usual physician (technical skills, interpersonal manner, and information-giving). To test for significant associations between the expenditure index and each summary scale, we used linear regression with each of the five summary scores as the dependent variable and the exposure measured as the HRR-level EOL-EI. The models controlled for age, sex, race, health status, and major U.S. region of residence ( $n = 9$ ). We also compared satisfaction scores on these scales across quintiles of spending. The analysis of satisfaction was based on respondents' first interview.

## RESULTS

### Patient Characteristics

Tables 1 through 4 in Part 1 present selected characteristics of each study cohort grouped into quintiles according to EOL-EI level in their HRRs of residence. Because the sample sizes are large, many small differences for the chronic disease cohorts were statistically significant. Notable differences were found in racial composition (more black persons in higher-expenditure HRRs) and income (higher-expenditure HRRs had more beneficiaries in the highest and lowest income categories). Smaller differences across quintiles were apparent in age, sex, comorbid conditions, and cancer stage. For the acute MI cohort, patients in the highest quintiles had a higher prevalence of non-Q-

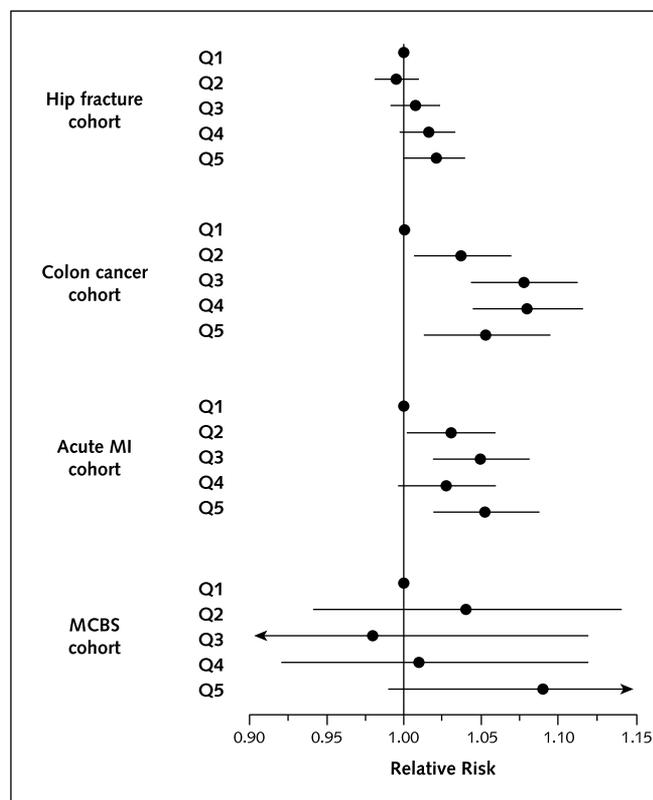
wave infarctions and congestive heart failure but a lower prevalence of creatine kinase levels greater than 1000 IU/L. For the MCBS cohort, residents of HRRs in the quintiles with higher EOL-EIs were more likely to report being in fair or poor health but were less likely to live in a facility.

Crude 30-day and 1-year mortality rates and average predicted 1-year mortality rates for each cohort are shown in Table 1. For the hip fracture cohort, average predicted mortality rates at 1 year were slightly but significantly lower in HRRs with a higher EOL-EI. In the acute MI cohort, however, average predicted mortality rates at 1 year were higher in HRRs with a higher expenditure index. No significant differences were found in predicted mortality across HRRs with differing expenditure indices for the colorectal cancer or MCBS cohorts. These findings reveal no consistent trend toward greater illness burden in HRRs with a higher expenditure index. Observed mortality tended to be lower than predicted in the lowest quintile and equal to or higher than predicted in the highest quintile.

### Mortality

Figure 1 presents the relative risk for death over 5 years for residents of HRRs in EOL-EI quintiles 2, 3, 4, and 5 (the higher quintiles) compared with residents of HRRs in the lowest quintile. In each cohort, an increase in EOL-EI was associated with a small increase in the risk for death. We repeated these analyses using the HRR-specific EOL-EI as a continuous variable both overall and in specific subgroups (Figures 2 through 4). A relative risk

Figure 1. Adjusted relative risk for death during follow-up across quintiles of Medicare spending.



Circles represent adjusted relative risk for death among residents of hospital referral regions in the specified quintile of the End-of-Life Expenditure Index (EOL-EI) compared to the risk for death among residents of hospital referral regions in quintile 1 of the EOL-EI; bars represent 95% CIs. MCBS = Medicare Current Beneficiary Survey; MI = myocardial infarction; Q1 = quintile 1; Q2 = quintile 2; Q3 = quintile 3; Q4 = quintile 4; Q5 = quintile 5.

greater than 1 indicated that residence in an HRR with a higher EOL-EI (higher expenditures) was associated with increased mortality. For every 10% increase in the EOL-EI, the relative risk for death over 5 years was as follows: hip fracture cohort, 1.003 (CI, 0.999 to 1.006); colorectal cancer cohort, 1.012 (CI, 1.004 to 1.019); acute MI cohort, 1.007 (CI, 1.001 to 1.014); and MCBS cohort, 1.01 (CI, 0.99 to 1.03). In none of the subgroups examined was a higher expenditure index associated with a statistically significantly lower mortality rate.

We repeated the mortality analyses using the alternate approach: assigning HRRs to different exposure levels based on the AC-EI. Residents of higher-spending HRRs, according to the AC-EI, had relatively similar baseline health status (Appendix Table 17, available at [www.annals.org](http://www.annals.org)) and yet received substantially more care (Appendix Table 18, available at [www.annals.org](http://www.annals.org)). The results of the mortality analyses are summarized in Table 2. For the hip fracture cohort, higher AC-EIs were associated with a small decrease in mortality rates. For all of the other cohorts,

mortality rates did not differ or increased slightly in regions with a higher AC-EI.

### Change in Functional Status

The average decline in functional status, as measured by using the HALex score, was about 2 points per year (on a 100-point scale) but did not differ across HRRs grouped according to quintiles of the EOL-EI (Table 3). In none of the models examined was an increased expenditure index associated with a statistically significant difference in the average rate of decline in health status (Appendix Table 10, available at [www.annals.org](http://www.annals.org)).

### Satisfaction with Care

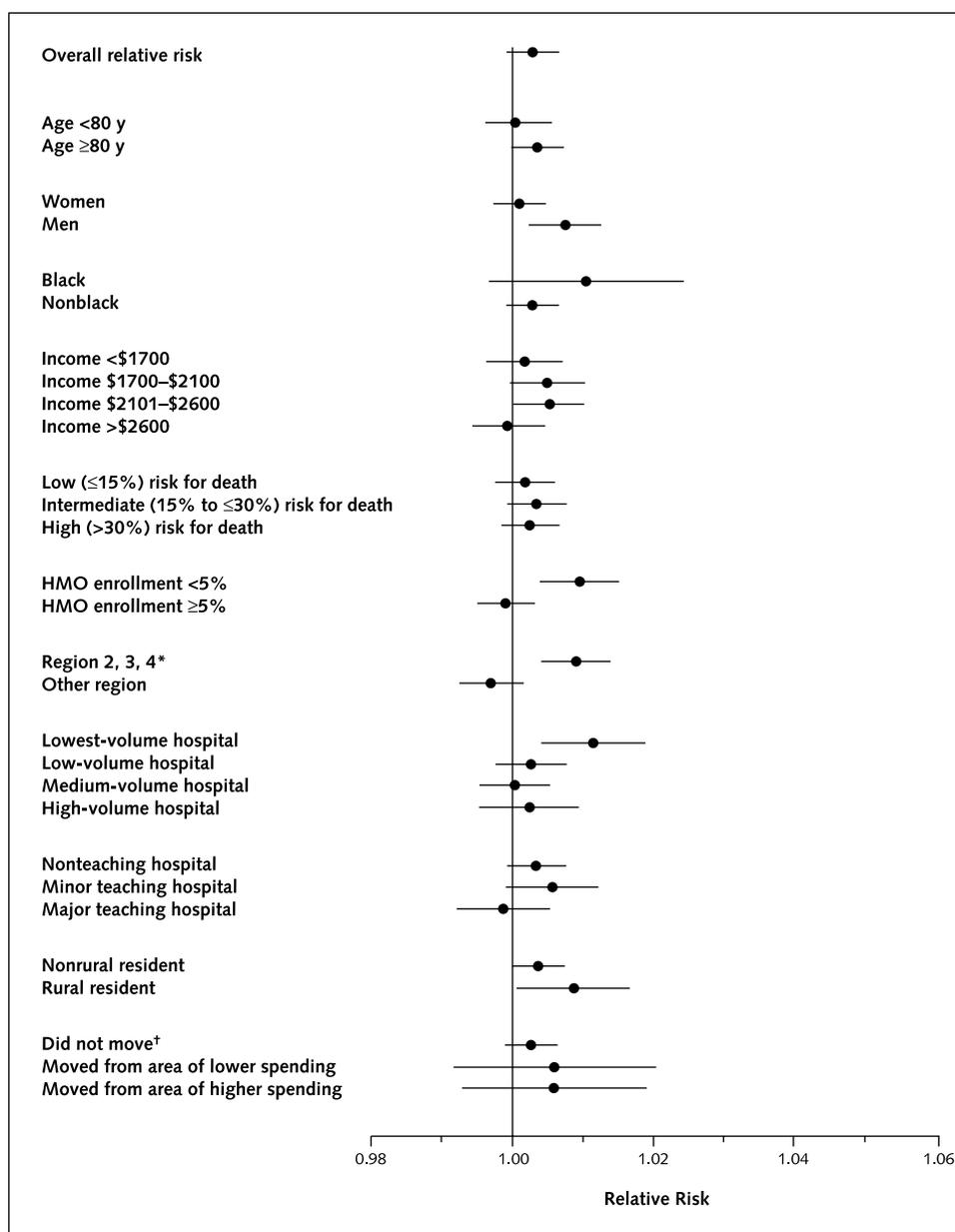
Figure 5 presents average change in adjusted satisfaction scores across quintiles (compared with quintile 1) for the five summary scales. Each scale ranges from 0 to 100, with higher scores implying greater satisfaction. We found substantial variation in satisfaction with care across the nine major U.S. regions (for example, Northeast and Mid-Atlantic), with satisfaction on each scale averaging over five points higher in the Northeast than in the South, controlling for other factors (data not shown). The differences in satisfaction across EOL-EI quintiles, however, were smaller than these regional differences and did not reveal a consistent pattern of greater satisfaction in HRRs with a higher expenditure index. The overall test for trend across HRRs indicated less global satisfaction with care and more satisfaction with interpersonal aspects of care in higher-spending HRRs. No differences were found across HRRs of differing expenditure indices for the other three measures of satisfaction with care.

## DISCUSSION

We conducted a cohort study in four distinct samples of Medicare enrollees, comparing the outcomes of care across 306 U.S. HRRs that differed dramatically in levels of Medicare spending and utilization. The primary exposure variable in this study, the EOL-EI, was intended to measure the component of regional variation in Medicare spending that is unrelated to regional differences in illness or price. The goal was to ensure assignment of HRRs (and the patients within them) to “treatment groups” that were similar in baseline health status but differed in subsequent treatment. The validity of the approach was confirmed by our finding that illness levels in each of the four study cohorts differed little across quintiles but that health care utilization rates and spending (for our four study cohorts) increased steadily and substantially across quintiles. Regardless of the measure used to characterize spending, residents of the highest-spending quintile received about 60% more care than those of the lowest-spending quintile.

As shown in detail in Part 1, these differences in spending were explained almost entirely by greater frequency of physician visits, more frequent use of specialist consultations, more frequent tests and minor procedures,

Figure 2. Adjusted relative risk for death associated with a 10% increase in Medicare spending overall and among specified subgroups of the hip fracture cohort.



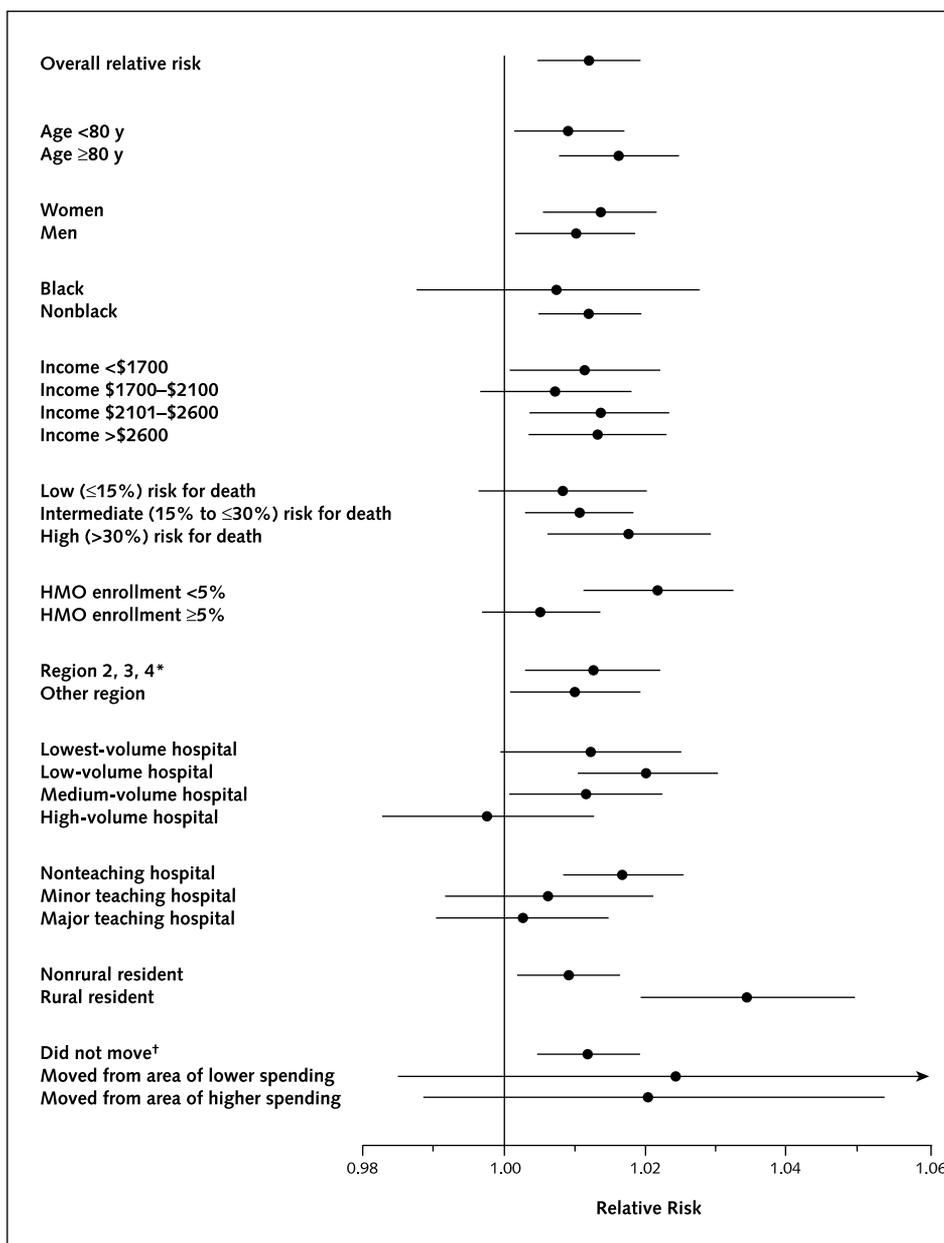
Income figures refer to the average monthly Social Security income of the patients' ZIP codes. Circles represent the adjusted relative risk for death associated with a 10% increase in the End-of-Life Expenditure Index across U.S. hospital referral regions; bars represent 95% CIs for the relative risk. \*Mid-Atlantic, South Atlantic, and Great Lakes regions. †Did not change hospital referral region of residence in the 1 to 2 years before index admission. HMO = health maintenance organization.

and greater use of the hospital and intensive care unit in high-spending regions. In this paper, Part 2, we found no evidence to suggest that the pattern of practice observed in higher-spending regions led to improved survival, slower decline in functional status, or improved satisfaction with care.

In Part 1, we discussed the major limitations related to the analyses of utilization. Here we focus primarily on the limitations related to our analysis of health outcomes. First, because of the observational nature of our study, the small

increase in mortality rate observed in regions with higher spending levels as assigned by end-of-life spending must be interpreted with caution. It is possible that the higher mortality rates observed in high-spending regions could be caused by the patterns of practice in regions where patients near the end of life are treated more intensively because of either relative overuse of such services as diagnostic tests and hospital-based care (for example, complications of treatment) or lower-quality care (for example, failure to provide such evidence-based services as immunizations).

Figure 3. Adjusted relative risk for death associated with a 10% increase in Medicare spending overall and among specified subgroups of the colorectal cancer cohort.

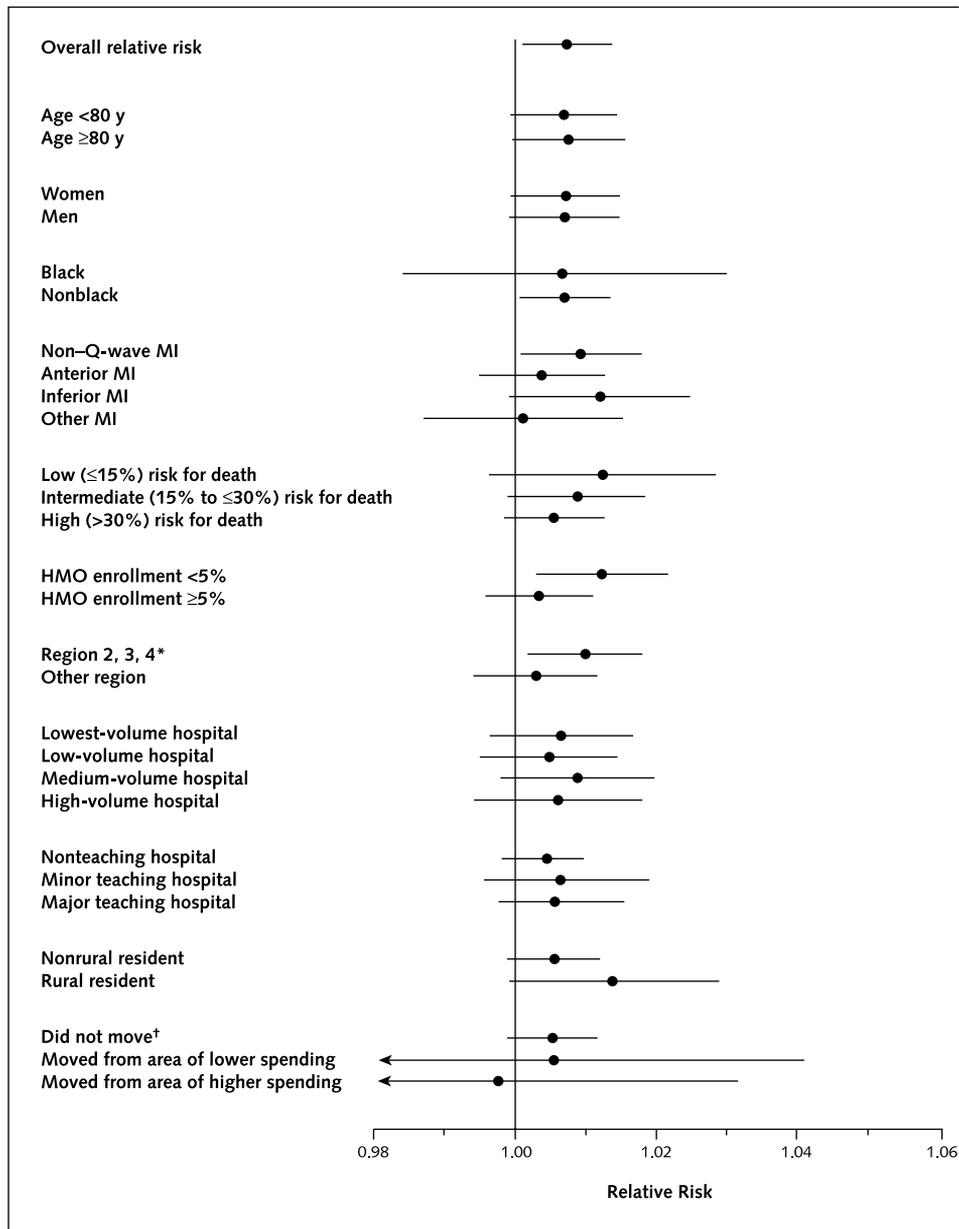


Income figures refer to the average monthly Social Security incomes of the patients' ZIP code. Circles represent the adjusted relative risk for death associated with a 10% increase in the End-of-Life Expenditure Index across U.S. hospital referral regions; bars represent 95% CIs for the relative risk. \*Mid-Atlantic, South Atlantic, and Great Lakes regions. †Did not change hospital referral region of residence in the 1 to 2 years before index admission. HMO = health maintenance organization.

On the other hand, it is possible that the increased mortality rate could be explained by unmeasured differences in case mix across regions of differing spending levels. We tried to account for this contingency in our study design (by use of the natural randomization approach) by controlling for numerous patient and regional attributes in our models. The stratified analyses (Figure 2) also suggest that unmeasured confounding is unlikely. Any potential confounder would have to operate similarly across all of

these strata. Some might argue, for example, that even among similarly ill patients, those who are aware of increased risk might move closer to teaching hospitals or to higher-spending regions (that is, that differences in patterns of migration, with sicker retirees moving to areas where capacity is greatest, explain our findings). That our findings are consistent across patients in teaching and nonteaching hospitals and among patients who had recently moved and those who had not argues against such con-

**Figure 4.** Adjusted relative risk for death associated with a 10% increase in Medicare spending overall and among specified subgroups of the acute myocardial infarction (MI) cohort.



Income figures refer to the average monthly Social Security income of the patients' ZIP codes. Circles represent the adjusted relative risk for death associated with a 10% increase in the End-of-Life Expenditure Index across U.S. hospital referral regions; bars represent 95% CIs for the relative risk. \*Mid-Atlantic, South Atlantic, and Great Lakes regions. †Did not change hospital referral region of residence in the 1 to 2 years before index admission. HMO = health maintenance organization.

foundings. Nevertheless, the fundamental limitation of observational studies must be acknowledged: We cannot determine whether the small increase in mortality rate is due to the treatment differences (regional differences in practice) or to unmeasured differences in the comparison groups.

Our analyses using the AC-EI provide additional evidence that the regional differences in Medicare spending observed across the United States are unlikely to provide important benefits in terms of improved survival. These

findings suggest that even when HRRs are stratified according to differences in how patients are treated during an episode of acute illness, regions that take the more intensive approach to acute care do not achieve better survival. For unmeasured confounding to have led to our findings, the unmeasured confounder would have to be correlated both with end-of-life spending and with regional differences in risk-adjusted acute care spending and would have to predict increased risk for death in all four cohorts. While this possibility must be acknowledged, it appears unlikely.

**Table 2. Adjusted Relative Risk for Death across Quintiles of Medicare Spending and Relative Risk Associated with a 10% Increase in Medicare Spending, as Estimated by Using the Acute Care Expenditure Index (Sensitivity Analysis)\***

Cohort	Relative Risk (95% CI)					Continuous Models
	Quintile of AC-EI					
	1 (Lowest)	2	3	4	5 (Highest)	
Hip fracture	1.00 (referent)	1.003 (0.989–1.016)	0.998 (0.984–1.013)	0.993 (0.978–1.009)	0.996 (0.979–1.014)	0.990 (0.983–0.998)
Colorectal cancer	1.00 (referent)	1.024 (0.994–1.055)	1.028 (0.995–1.062)	1.022 (0.987–1.057)	0.995 (0.959–1.032)	1.000 (0.985–1.016)
Acute MI	1.00 (referent)	1.025 (0.999–1.053)	1.029 (1.000–1.058)	1.027 (0.997–1.059)	1.037 (1.004–1.071)	1.009 (0.996–1.023)
MCBS	1.00 (referent)	1.19 (1.04–1.36)	1.16 (0.98–1.37)	1.05 (0.92–1.18)	1.08 (0.95–1.23)	0.99 (0.94–1.05)

\* Data were obtained from Cox regression models testing the association between residence in higher-spending hospital referral regions (defined on the basis of the AC-EI) and mortality for up to 5 years. For the quintile models, hospital referral regions were grouped into quintiles of increasing AC-EI levels. For the continuous models, data represent the relative risk for death associated with a 10% increase in the level of the AC-EI in the hospital referral registry of residence. For additional details, see Appendix, Section F, available at [www.annals.org](http://www.annals.org). AC-EI = Acute Care Expenditure Index; MCBS = Medicare Current Beneficiary Survey; MI = myocardial infarction.

The consistency of our findings across different measures of the exposure and different study cohorts argues that the increased Medicare spending in high-cost regions provides no important benefits in terms of survival.

A second limitation of this study is that we were able to examine functional outcomes and satisfaction with care only in the general population sample and not in our three high-risk, chronic disease cohorts. Although the quality of care provided to the three chronic disease cohorts appeared no better in higher-spending regions, it remains possible that the increased use of specialists, diagnostic tests, and hospital-based care led to better functional outcomes, quality of life, or satisfaction with care. Further research is warranted to address this possibility.

It is also possible, however, that the increased intensity of treatment provided to severely ill patients could lead to poorer quality of life and less satisfaction. The most striking differences in practice in higher-spending regions are found in the care of patients near the end of life, regardless of whether the definition of a “high-spending” region is based on one of the indices used here or on average per capita Medicare spending (8). Our findings suggest that the more aggressive patterns of practice observed in high-spending regions offer no benefit in terms of their major aim, which is improving survival. In addition, we know of no evidence to suggest that the nearly threefold greater use of invasive life support (intensive care unit utilization, emergency intubation, and feeding tubes) seen in high-

spending regions results in improved quality of life or satisfaction with care.

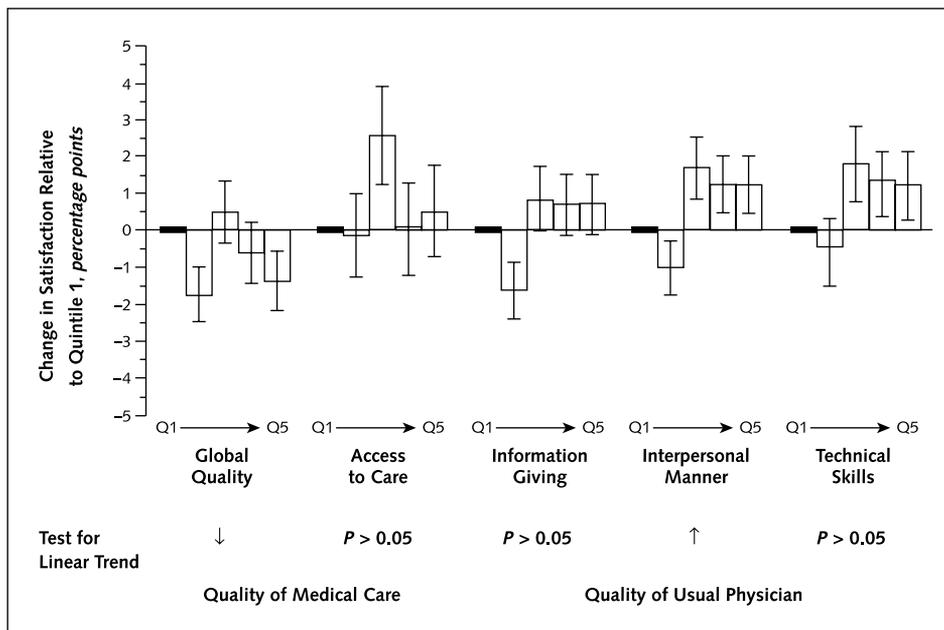
Finally, because our primary exposure variable is ecological, in the sense that residence in a region with higher Medicare spending is a characteristic of patients’ environment, some may be concerned that our inferences are suspect because of the “ecological fallacy” (39, 40). The ecological fallacy occurs when one tries to answer a purely individual-level question (for example, Is high saturated fat intake associated with a person’s risk for heart disease?) with data derived from groups of people (for example, the average risk for heart disease in a group). The fallacy lies in assuming that an association observed at one level of aggregation (for example, countries) automatically implies the association at a different level (for example, individual patients). It is most likely to occur when both outcomes and predictors of that outcome (including measures of exposure and measures used to adjust for group differences) are ascertained only for the groups and not for individuals. Our research interest was to determine whether a system-level variable—increased Medicare spending in a given region—leads to better care or better outcomes for the average individual Medicare enrollee residing in that region. We chose an ecological (system-level) exposure measure because it is the appropriate exposure measure for this specific research question. In addition, because we were interested in the effects of regional spending on the care of individual patients, our unit of analysis was the patient.

**Table 3. Average Change per Year in Functional Status on Health Activities and Limitation Index among Participants in the Medicare Current Beneficiary Survey according to Medicare Spending in the Hospital Referral Region of Residence\***

Variable	Quintile of EOL-EI				
	1 (Lowest)	2	3	4	5 (Highest)
Change in functional status (95% CI)	-1.96 (-2.36 to -1.55)	-2.18 (-2.65 to -1.71)	-2.28 (-2.84 to -1.71)	-1.94 (-2.40 to -1.47)	-1.96 (-2.42 to -1.50)

\* Scores on the Health Activities and Limitations Index at follow-up ranged from 0 (death) to 100 (excellent self-assessed health and no limitations). Results controlled for differences in age, sex, race, chronic conditions, residence in a facility, residence in a metropolitan region, whether respondent was bedridden, smoking status, income, education, marital status, and supplemental insurance coverage. EOL-EI = End-of-Life Expenditure Index.

Figure 5. Satisfaction with care.



An arrow pointing upward indicates a positive association between increased spending and satisfaction. Bars represent 95% CIs. Q1 = quintile 1; Q5 = quintile 5.

We measured outcomes and variables used to adjust for group differences at the patient level and could therefore control effectively for individual characteristics in the analysis. The ecological fallacy therefore applies neither to our design nor to our analysis. We can legitimately conclude that the average Medicare patient in higher-spending regions (and the average patient in each subgroup examined) receives much more care than those in lower-spending regions and that this additional care is not associated with better access to care, higher-quality care, or better health outcomes.

Previous research on regional variations in utilization and outcomes has been largely ecological in design, examining cross-sectional correlations at the area level between spending and utilization (5) or between spending or utilization and mortality (9, 12, 22). These earlier studies have been criticized for weak designs, inadequate individual-level measures to control for potential differences in case mix, insufficient clinical detail on the process of care to allow inferences on potential causal pathways to be drawn, and limited outcome measures. Our study addressed each of these concerns. We adopted a longitudinal design and obtained extensive baseline data on patients' health and socioeconomic status that allowed us to control for potential differences in need for care. We were also able to characterize in detail patients' access to care, use of services, and quality of care. Finally, we showed that these regional differences in utilization and outcomes were consistently seen in each subgroup of the samples. Black or white, poor or rich, high-risk or low-risk, patients in higher-spending regions received much more care (Appendix Tables 12

through 14, available at [www.annals.org](http://www.annals.org)) but did not have better outcomes.

Our study provides limited guidance on the potential impact of reducing regional disparities in spending or the implementation of policies to constrain the use of these supply-sensitive services. From a clinical perspective, it is important to recognize that our study does not address the question of how the amount of care for an individual patient in a specific case would affect that patient's clinical outcome. What may appear to be relatively low-risk interventions (such as hospitalization or ordering a diagnostic test) may cause harm in some settings, just as failure to provide these or other services (such as bypass surgery in high-risk patients) may cause harm in other settings. From a policy perspective, our study does not tell us definitively that it is possible to reduce Medicare spending within a particular region without affecting patient care or outcomes. Previous research has shown that vulnerable populations may be harmed by reduced access to care (23, 24) or as a consequence of public hospital closures (25). It is not always clear, for example, whether services such as specialist consultations are wasteful or beneficial. The potential adverse impact of reductions in the use of beneficial services and disruptions in current practice patterns underscores the importance of further research on these issues and of the implementation and evaluation of demonstration projects intended to improve quality of care and promote conservative approaches to managing patients with chronic disease (8).

Debates over the need for further growth in medical spending and expansion of the medical workforce are

largely based on the assumption that additional services will provide important health benefits to the population served. Our study suggests that this assumption is unwarranted. Our study also underscores the need for research to determine how to safely reduce spending levels. If the United States as a whole could safely achieve spending levels comparable to those of the lowest-spending regions, annual savings of up to 30% of Medicare expenditures could be achieved (3). Such savings could provide the resources to fund important new benefits, such as prescription drugs or expanded Medicare coverage to younger age groups, or to extend the life of the Medicare Trust Fund to better cover the health care needs of future retirees.

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